Urinalysis
Sample collection

- „night break” 6-8 h – first morning sample
- dry, sterile container
- clean genital area
- mid-stream
- 2 hrs: collection - test
  - if it’s impossible – store in the fridge (+4°C) (up to 24 hrs)
What can we find in the urine?

• Physical features
  – color
  – clarity
  – specific gravity
  – smell
  – volume

• Chemical features
  – protein
  – glucose
  – ketones
  – bile
  – urobilinogen
  – azotines
  – pH
What else can we examine?

• Urine sediments
• 24 hour urine collection
Color

- **yellow**
  - shades of yellow
  - from very pale or colorless to very dark or amber.

- **red**
  - from pink to brown
  - blood (centrifuged specimen shows RBCs)
  - drugs: rifampicin, ibuprofen, doxorubicin, L-DOPA,
  - fruits: blackberries, beets,
  - porphyria
  - presence of urates
  - bile
Color

• brown/black
  – darkens during standing (phenol, cresol, naphtol intoxication)
  – ferrum
  – alkaptonuria
  – melanin
• dark orange
  – bile
• blue
  – methyl blue
• Green
• bacteria
• drugs
Clarity

- clear
- morphotic elements
  - RBC, WBC, epithelial cells
- bacteria
- fat

- not always decreased clarity is a result of pathology
  !!!
  - phosphates
Screening test - dipsticks

• Thin, plastic strips on which are fixed chemically impregnated squares of porous material.
• Are able to react with various components of the urine
• Can detect: pH, specific gravity, protein, glucose, nitrites, ketones, bile, urobilinogen, leukocytes and RBC
• Vitamin C can stop oxydase in reaction with glucose and esterase in reaction with leukocytes
Urine Specific Gravity

- renal tubular function
  - 1,003-1,030 g/ml
  - N: 1,020 g/ml (1,015-1,020)

- urinometer

- dipstick tests
  - falsly (+) → protein, ketones
  - falsly (-) → glucose, ↑pH, urea
Urine Specific Gravity

• **increase**
  – Temperature (fever)
  – osmotic diuresis
    • proteinuria, glukosuria, radiographic contrast medium, mannitol, dextran
  – antibiotics
  – detergents

• **Decrease**
  – diluted specimen
  – diuretics
  – hypothermia
  – acidosis
Osmolality

- 500-1200 mOsm/l
- Last two digits of specific gravity x 26

- Renal’s function control
- Low osmolality – renal acute renal failure
- High osmolality – prerenal acute renal failure
pH 5.5-6.5

• ↑
  – vegetarian food
  – bacterial infection
  – drugs

• ↓
  – bacterial infection (Mycobacterium tuberculosis
  – meat in diet
  – metabolic acidosis
  – methyl alcohol
  – fever
Volume (I)

- Depends on:
  - diet
  - fluids intake
  - loss of fluides
  - renal function
  - age
  - sex
  - psychic condition

Adults
- 600-2500 ml / 24h (average - 1200)
- night volume usually <700ml/24h
- specific gravity < 1,015

Children
- premature infants - 1-3ml /kg/h
- full-term infants - 15-60 ml/24h
- 2 weeks - 250-400 ml/24h
- 8 weeks - 250-400 ml/24h
- 1 year - 500-600 ml/24h
Volume (II)

**ANURIA** < 100 ml/24h
- bilateral complete urinary tract obstruction
- acute cortical/tubular necrosis
- necrotizing glomerulonephritis

**OLIGURIA**
- < 500 ml/24h (or 20ml/h)
- <15-20ml/kg/24h in children

min. 500ml/24h !!

**POLIURIA**
- > 2500 ml/24h

*diabetes insipidus*
Protein

- < 150 mg/24h
  - not detected by routine clinical methods
  - Tamm - Horsfall protein
  - products of epithelium degradation
- detection of various renal disorders
- detection of Bence-Jones proteinuria (problem !)
- > 3 (3,5) g/24h – severe proteinuria
Functional proteinuria

- not associated with systemic or renal damage.
  - severe muscular exertion
  - pregnancy
  - orthostatic proteinuria
  - changes of temperature
- slight to mild proteinuria associated only with the upright position
- etiology is unknown
Organic proteinuria

• associated with
  – systemic disease
  – renal pathology
Prerenal proteinuria

- Fever
- Venous congestion
- Renal hypoxia
  - severe dehydration
  - shock
  - severe acidosis
  - acute cardiac decompensation
  - severe anemias
- Hypertension
- Bence Jones protein – Myeloma multiplex
Renal proteinuria: primary kidney disease

• Glomerulonephritis
• Nephrotic syndrome
  – primary or secondary
• Destructive parenchymal lesions
  – tumor
  – infection
  – infract
Renal proteinuria

• glomerular
  – selective – small proteins (40-90kD)
    • albumines (transferin, alfa-1-antitripsin) – 30mg/24h
  – nonselective – albumins + globulins
    • Ig (nephrotic syndrome, multiple myeloma, diabetes)

• tubular
  – disturbed reabsorbtion from renal tubules
  – B$_2$-microglobulin – 0,25mg/24h
Postrenal proteinuria

- Infection of the renal pelvis or ureter
- Cystitis
- Urethritis or prostatitis
- Contamination with
  - vaginal secretions
  - sperm
Microalbuminuria

• 30-300 mg/24h
• first symptom of diabetic nephropathy
• not detected with dipstick tests !!!
Glucose

- not detectable by routine methods!
- renal threshold
  - 180mg/100ml serum glucose level
  - pregnancy – 140-150mg%
“Physiological glucosuria”

- glucose overload
- pregnancy
- prolonged stress
Glucosuria without hyperglycemia

- glucosuria of pregnancy (also lactosuria)
- renal glucosuria
- inborn metabolic errors - Fanconi`s syndrome
- nephrotoxic chemicals
  - carbon monoxide
  - lead
  - mercuric chloride
Glucosuria with hyperglycemia

- diabetes mellitus
  - the most common and important
- increased intracranial pressure
  - tumors, hemorrhage, skull fracture
- endocrine diseases or hormone producing tumors
  - Cushing`s syndrome, pheochromocytoma
- hyperthyroidism
- after myocardial infarction
  - occasionally, transient
- after some types of anesthesia
  - ether
Tests for urine glucose

• glucose oxidase enzyme paper dipsticks

• Clinitest
  – based or copper sulfate reduction by reducing substance

• false positive results (reduction methods)
  – hydrogen peroxide
  – hypochlorites (found in certain cleaning compounds)
  – sugars other than glucose  galactose, lactose
  – hemogentisic acid (alkaptonuria)

• large amounts of vitamin C
  – false negative results with the glucose oxidase methods
  – false positive results with reducing substance methods
Ketonuria (I)

- N: (-)
- acetone, beta-hydroxybutyric acid, acetoacetic acid (dipstick tests)
- screening for ketoacidosis (diabetes mellitus)
- confirmation of fasting in insulinoma
Ketonuria (II)

• metabolic conditions
  – diabetes mellitus
  – renal glycosuria
  – glycogen storage disease

• dietary conditions
  – starvation
  – high-fat diet

• increased metabolic requirements
  – hyperthyroidism
  – fever
  – pregnancy and lactation
Nitrites

- N: (-)
- indirect test for bacteriuria
- sensitivity of the nitrite test versus quantitative urine culture is only about 50%
- „night-break” at least 8hrs
Bile

• conjugated bilirubin
  – not detected in normal condition

• ↑
  – biliary tract obstruction
    • extrahepatic (common duct obstruction)
    • intrahepatic

• liver cell injury
  • active cirrhosis
  • hepatitis virus hepatitis)
Urobilinogen

- N: trace
- produced from conjugated bilirubin by metabolic activity of bacteria in the intestine
- the 24-hour specimen must contain a preservative
- routine specimen test must be done within 30 minutes after collection
  - rapidly oxidizes in air to nondetectable urobilin
Urobilinogen

- \(\uparrow\)
  - marked increase in production secondary to increase in serum unconjugated bilirubin
    - hemolysis
  - parenchymal liver damaged
    - cirrhosis or severe hepatitis

- \(\downarrow\)
  - cholestasis
  - \(\downarrow\) number of bacteria in intestine
Microscopic examination of urinary sediment

- centrifuged urinary sediment
- filed of view - 40x magnifying lens
Red blood cells

- 0-5
Prerenal haematuria

• clotting disorders
  – purpura
  – anticoagulants

• blood dyscrasias
  – sickle cell anemia or leukemia

• malignant hypertension

• subacute bacterial endocarditis
Renal haematuria

- renal infraction
- collagen diseases
  - lupus
  - polyarteritis nodosa
- renal tumors
- tuberculosis
- acute glomerulonephritis
Postrenal haematuria

- benign prostate hyperplasia
- bladder or urethral infection
- cystitis, urethritis, and prostatitis
- in the female, menstrual blood
- stones
White blood cells

- 0-8
- > 8 => pyuria

- infections
- fever
- dehydration
- physical exertion
White blood cells

• may originate anywhere in the urinary tract

• renal origin
  – accompanied by significant proteinuria
  – WBC casts
  – WBCs in clumps

• lower urinary tract
  – may be associated with slight proteinuria
Casts

- protein conglomerates
- shape of the renal tubules in which they were formed
  - distal and collecting tubules
- pH:
  - protein casts dissolve in alkaline medium.
- Concentration
  - dissolve in dilute medium.
- Proteinuria
- Stasis
  - time for protein precipitation within tubules.
Hyaline casts

- composed of protein alone (Tamm - Horsfalle protein)
- they pass almost unchanged down the urinary tract
  - dull
  - nearly transparent
  - reflect light poorly compared with waxy casts
- often hard to see
- sometimes cellular elements may be trapped within hyaline casts
- basic type of casts
Cellular casts

- cells are trapped inside renal tubules in a protein matrix
- the cast is named for the cells inside it
Cellular casts

- RBC casts
  - glomerulonephritis
  - presence of RBC in urine
Cellular casts

- WBC casts
  - pyelonephritis
Cellular casts

• Epithelial
  – desquamated renal epithelial cells
  – tumors, glomerulonephritis,
Crystals

• often overemphasized in importance
• may be a clue to calculus formation and certain metabolic diseases
• tend to be pH dependent:
  • Acidic urine:
    – uric acid
    – cystine
    – calcium oxalate.
  • Alkaline urine:
    – phosphates (triple phosphate - magnesium ammonium phosphate)
Crystals

Calcium oxalate  Triple phosphates

Amorphous urates  Uric acid
Microbes and parasites

• **Trichomonas vaginalis**
  – special procedure of sample collection
  – sample MUST be stored in 37°C
  – short time: collection – examination (minutes)

• **Bacteria**
  – movement
  – sterile container

• **Yeast**
  – relatively common sediment finding
    • Candida albicans - most common
  – often misdiagnosed as RBCs